LAND-USE HISTORY OF CALIFORNIA AND CHILE AS RELATED TO THE STRUCTURE OF THE SCLEROPHYLL SCRUB VEGETATIONS

H. A. Mooney, E. L. Dunn,
Department of Botanical Sciences
Stanford University, Stanford, California 94305
Frances Shropshire, and Leo Song, Jr.
Department of Botanical Sciences
University of California, Los Angeles 90024

The vegetations of the five Mediterranean climatic areas of the world, California, central Chile, southwest Australia, South Africa, and the Mediterranean, have been long cited as offering classical examples of convergence. All are far separated geographically, all have floras which are uniquely different from one another, and yet, all have vegetation types which resemble one another in their physiognomic aspects. The most distinctive physiognomy of this climatic type is that of a dense, often impenetrable scrubby vegetation composed of diverse, hard-wooded, evergreen species. Although these generalities have been long known, there have been surprisingly few detailed comparisons between the vegetations of two or more of these regions until recently (Naveh, 1967; Specht, 1969a,b; Mooney, et al., 1970).

We are presently making a study of the comparative physiology of sclerophyll shrubs of California and Chile in an attempt to understand the selective basis for the convergence phenomenon. In the process of this study we have gathered information on the characteristics of the dominant plants of these areas. This information forms the basis for an analysis of the degree of convergence between areas. In brief, we are of the opinion that these vegetations are not convergent as has been supposed in certain aspects and that the probable basis for this lack of convergence lies in dissimilar treatments of these vegetations by man through time, and not because of different evolutionary adaptations of these vegetations to essentially identical environmental conditions. This latter possibility, however, is receiving further study.

Degree of Vegetation Convergence

The distribution of the scrubby sclerophyll vegetation of Chile (the "matorral") and of California (the "chaparral") is generally similar (fig. 1) with the centers lying near 35° latitude. The greater extension of the distribution of the chaparral vegetation as compared to that of the matorral is related to the distributions of summer dry climates on these two continents. The Mediterranean-type summer drought extends to much higher latitudes in North America than in South America (Mooney, et al., 1970). At the lowest latitudes (32–34°) the correspondence of climatic types at any given equal position is very close (fig. 2). It is at such latitudes that we make our vegetation comparisons here.

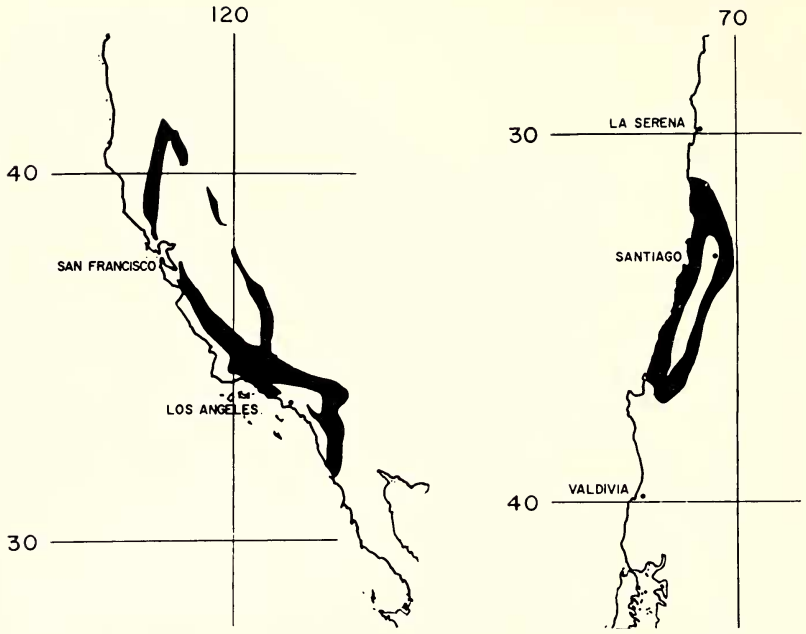

FIG. 1. Extent of the sclerophyll scrub vegetations of California and Chile.

In both of these areas the scrubby sclerophyll vegetations are bordered on the mesic side by a broadleaf, predominately evergeen, sclerophyll forest, and on the dry side by vegetations which are dominated by drought deciduous subshrubs. The details of this entire vegetation sequence and corresponding climatic gradient have been given elsewhere (Mooney, et al., 1970).

A list of the dominant or characteristic chaparral shrubs of southern California and a comparable list for the corresponding northern Chilean sclerophyll area are given in Table 1. The complete lack of taxonomic similarity between these areas is readily apparent.

We have compared the heights, leaf sizes, types, and functions as well as the spininess and flowering periods of these plants (table 2). Both the chaparral and matorral are composed of shrubs which are mostly 2–4 meters high and which have simple leaves of a size mainly between 255 and 2025 mm^2. Almost 50% of the shrubs from both areas are known fire sprouters. The great similarities in these attributes alone lend a high degree of closeness of general appearance of these vegetations.

These vegetations differ, however, in fine detail in that the chaparral of California is predominately evergreen, whereas the matorral of Chile has a fair number of drought-deciduous types in addition to evergreen species. Further, there is a larger number of spiny shrubs in the matorral and the general flowering activity is earlier. These characteristics of

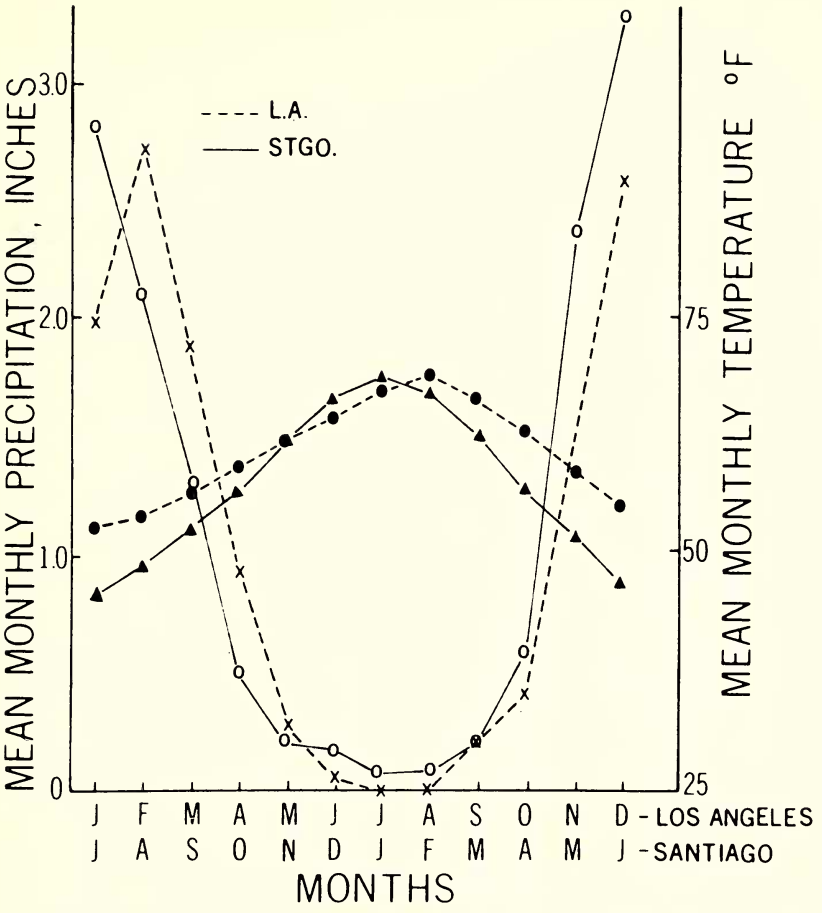

FIG. 2. Mean monthly temperature and precipitation in Los Angeles, California and Santiago, Chile.

earlier flowering, more drought deciduous and spiny types are indicative of more xeric conditions in the matorral. This is probably true, but is not evident from more detailed climatic comparisons than are presented here. Rather, this greater xerophytism of the matorral habitat is probably due to the general degradation of the vegetation by man.

Not all of the species listed for either Chile or California may be found together in any given habitat. In the matorral, the unique palm, *Jubea chilensis,* is restricted to the coastal mountains where it may occur in abundance. *Lithraea caustica, Quillaja saponaria, Kageneckia oblonga, Escallonia pulverulenta* are all evergreen schlerophylls which are generally common everywhere although rarely found in closed stands. In a phytosociological study of the matorral near Santiago, Schlegel (1963)

Table 1. Characteristic Dominant Plants of the Chaparral and Matorral

The matorral list is derived from personal observations. The list for the Southern California chaparral is from Knapp (1965). The lists do not include elements from the adjacent evergreen forest or semi-arid coastal scrub vegetation types.

Northern Chile Matorral	*Southern California Chaparral*
Acacia caven (Mol.) Hook. & Arn.	*Adenostoma fasciculatum* H. & A.
Adesmia arborea Bert.	*A. sparsifolium* Torr.
Azara dentata R. & Pav.	*Arctostaphylos glauca* Lindl.
Baccharis linearis (R. & Pav.) Pers.	*A. parryana* Lemmon
Baccharis paniculata DC.	*A. pringlei* Parry
Centaurea chilensis Hook. & Arn.	*A. canescens* Eastw.
Colletia spinosa Lam.	*A. gladulosa* Eastw.
Ephedra andina Poepp. ex C. A. Mey.	*A. pungens* HBK
Escallonia pulverulenta (R. & Pav.) Pers.	*Ceanothus crassifolius* Torr.
	C. leucodermis Greene
Eupatorium salvia Colla	*C. oliganthus* Nutt. in T. & G.
Gochnatia fascicularis D. Don	*C. spinosus* Nutt.
Jubea chilensis (Mol.) Baillon	*C. tomentosus* Parry
Kageneckia oblonga R. & Pav.	*C. verrucosus* Nutt. in T. & G.
Lithraea caustica (Mol.) Hook. & Arn.	*C. megacarpus* Nutt.
Lobelia salicifolia Sweet	*Cercocarpus betuloides* Nutt.
Maytenus boaria Mol.	*Fremontia californica* Torr.
Podanthus mitiqui Lindl. in Loud.	*Garrya veatchii* Kell.
Porlieria chilensis Johnst.	*G. flavescens* Wats.
Proustia pungens Poepp. ex Less.	*G. fromontii* Torr.
Quillaja saponaria Mol.	*Heteromeles arbutifolia* M. Roem.
Retanilla ephedra (Vent.) Brongn.	*Mimulus longiflorus* (Nutt.) Grant
Schinus polygamus (Cav.) Cabrera	*M. puniceus* (Nutt.) Steud.
Trevoa trinervis Miers	*Pickeringia montana* Nutt.
Teucrium bicolor Sm. in Rees.	*Prunus ilicifolia* (Nutt.) Walp.
	Quercus dumosa Nutt.
	Rhamnus crocea Nutt. in T. & G.
	Rhus ovata Wats.
	Trichostema lanatum Benth.

found that the total shrub cover in a variety of sites was usually much less than 100% and usually near 50%. These evergreen species are probably the climax types for this climate. *Acacia caven* is a winter deciduous shrub which forms a savanna in certain areas, mainly on the gentle slopes and valley bottoms. *Proustia pungens* and *Trevoa trinervis* are both drought deciduous spiny shrubs which are very common, either occurring in almost pure stands or among the evergreen sclerophylls listed above. *Proustia* and *Trevoa* probably represent disclimax species. It is the widespread mixing of these diverse types which leads to a general vegetation which diverges from its California counterpart.

In contrast to the relatively open vegetation composed of mixed ecological types of the matorral, the chaparral generally forms over 100% cover and is composed essentially only of evergreens. *Adenostoma fasciculatum,* a needleleaf evergreen is the most prevalent species of all those listed for the chaparral. The closely related *A. sparsifolium* is very fre-

quent in the mountains of southernmost California. One or more of the species of *Ceanothus* and *Arctostaphylos* may be locally abundant in any given area. *Cercocarpus, Heteromeles,* and *Quercus,* all evergreen sclerophylls, are particularly characteristic and abundant everywhere.

There are no areas in California comparable to those in Chile where the vegetation has been repeatedly opened and in which there appears such an admixture of shrub types. The vegetation which borders the arid fringe of the chaparral is composed of partial drought deciduous subshrubs such as *Artemisia californica, Salvia mellifera, S. leucophylla, S. apiana,* and *Encelia californica.* Certain of these shrubs may, in certain limited and clearly discernable areas become successional species in the chaparral habitat.

Table 2. Characteristics of the Dominants of the Sclerophyll Scrub[1]

	Percentage occurrence	
	California	Chile
Plant height		
0–1 meters	6.9	4.2
1–2 "	20.7	33.3
2–4 "	55.0	50.0
4+ "	17.2	12.5
Leaf size		
none	0.0	8.3
less than 25 mm^2	6.9	16.6
" " 255	17.2	8.3
" " 2025	72.4	50.3
" " 18225	3.4	8.3
Leaf type		
Compound	3.4	13.6
Simple	93.1	81.8
Lobed	3.4	13.6
Leaf function		
Drought deciduous[2]	0.0	22.7
Partial drought-deciduous[3]	10.0	22.7
Evergreen	90.0	50.0
Winter deciduous	0.0	4.6
Spiny branches or leaves	17.2	29.2
Peak flowering months[4]		(Equivalent)[5]
	February 45	57 April
	March 72	61 May
	April 69	43 June
	May 45	39 July

[1] These data derived from field observations and the examination of herbarium specimens and relevant floras.
[2] Abscission layer forms and all leaves drop during drought season.
[3] Leaves dry during drought season. Terminal leaves may remain during peak of drought. If water is availalbe many leaves will remain.
[4] Percentage of species in flower on given month.
[5] Northern hemisphere equivalent months; e.g., the June for Chile is actually December.

Land Use

The Past

In order to understand the vegetation of the Mediterranean climatic regions of California and Chile it is essential to appreciate the history of land use in these two areas. Knowledge of the treatment of the landscape by the Indians as well as the early European settlers is incomplete. Detailed information of use patterns subsequent to settlement is often lacking; however, enough salient features are known to establish the dissimilarities in usage through time.

Both Chile and California were first penetrated by the Spaniards at virtually the same time; Chile by Diego de Almagro's expedition in the late 1530's and Alta California by Juan Rodriguez Cabrillo in 1542. It is estimated that at that time there were approximately one-half million Indians in the central zone of Chile—in this case, Valparaiso to Puerto Montt (James, 1959; Faron, 1968)—and probably about 200,000–75,000 in southern California (Aschmann, 1959)—in California. These populations were very small compared to the many millions known to have existed in the Aztec and Inca empires. These relatively low Indian densities (although high for their areas since as many as one-quarter of the total U.S. Indian population may have resided in California at the time of contact by the Spanish) were in part responsible for the slow development of at least Chile by the Spaniards, since the early Spanish system of land usage was based on tributes of labor by the native population on trusts granted by the Crown—the *encomienda*. Initially, land without a labor force was of little value. The uncooperativeness and hostility of the native Indians of Chile, the Araucanians, controlled to a large degree the pace of development of this area.

A successful colony was established by Pedro de Valdivia in Santiago, Chile, upon its initial founding in 1541. Santiago lies at the base of the Andes near the northern extremity of the Central Valley (fig. 1). Today the northern valley is virtually treeless. The Andean and Coastal Range slopes are, however, covered with a matorral scrub in various states of disturbance. In the Santiago region, in protected cool canyons, either in the foothills of the Andes or in the Coastal Range, isolated forests of *Cryptocarya alba* (peumo) may be found. Such forests were perhaps more extensive in the Valley proper at the time of the arrival of the Spaniards and formed a mosaic with matorral and grassland (McBride 1936). These scattered trees were evidently quickly harvested in the initial settlement. Fire was used to clear the lowland matorral so that the land could be used for agriculture.

The extent of the Santiago settlement and the intensity of agricultural activity quickly increased. Within a few years European crops were being produced and the settlement extended 90 miles to the south. By 1630 the

land about Santiago was producing crops, stock, and agricultural products in abundance and of high quality. The labor to produce this harvest was primarily Indian (McBride, 1936).

The first really extensive use of the land in the Central Valley of Chile was for cattle raising. The initial cattle brought from Peru and Panama multiplied to such an extent that even in the early days there were complaints of overgrazing on local plots of land.

During the first 200 years following settlement, extensive cattle ranches characterized the northern Central Valley. These cattle utilized natural pastures in the Central Valley, the Coast Ranges, and in the summer the high Andean meadows.

It is important to note that all of this intensive utilization of the landscape in Chile was concentrated in the Central Valley in the Santiago region. The Bio-Bio River remained the southern frontier for a very long period to come. With the exception of the well-watered Aconcagua Valley north of Santiago there was little land of agricultural use in the arid north. Comparatively, it is of importance to note that during this 200-year-long period of land usage in Chile by the Europeans there was no attempt to colonize the lands of Alta California. This did not come about until the founding of the San Diego Mission in 1769.

In Chile, the encomiendas were finally abolished in 1791 and from them evolved extensive haciendas. Primogeniture, inheritance by the eldest son, kept properties large. It wasn't until the mid-1800's that this inheritance system was terminated. Still, by 1880 land was concentrated into the holdings of fewer people than ever before or since (as recently as 1955, 4.4% of the Chileans owned 80.9% of the total farm lands). Stock raising remained very important in the Central Valley. By the early 1900's, however, the number of cattle leveled off and has not increased greatly even up to the present (Thiesenhusen, 1966).

Labor for these haciendas was provided primarily by Chilean tenant workers—the *inquilino*. The very low standard of living of these impoverished farm workers probably had a long-term detrimental effect on the landscape of the central region. McBride (1936) describes the intensive utilization of the matorral-covered slopes surrounding the Valley by wood gatherers and sheep herders. Present land reform is changing this system; however, even today one may see anything of potential value avidly collected from the hillsides—firewood, bark, roots, and herbs.

Apparently, wood gathering for charcoal for heating and cooking was a major force in the destruction of the local forests and scrublands in the central Chile region (di Castri, personal communication). The long-term supply of energy from the native plants to the population of the Santiago area resulted in the continual degradation of the vegetation. The wood gathering activity first opened the vegetation, and subsequent intensive grazing further degraded it.

After 200 years of neglect subsequent to discovery, Alta California was

finally colonized by the Spaniards, starting in 1769 with the establishment of the San Diego Mission. Members of the early land expeditions up the coast noted the grassy coastal plains and valleys, "with places adapted for all kinds of cattle" (Priestley, 1937). Certain valley floors, however, evidently were covered with shrubs of the coastal sage vegetation. The chaparral which presumably, then as now, covered the upper hill slopes was evidently periodically burned by the Indians to aid in hunting and to promote the growth of edible plants (Simpson, 1938; Aschman, 1959).

By 1823 the last of the 21 missions was established at Sonoma north of San Francisco. The functions of the missions were to Christianize the natives and provide islands of civilization prior to the arrival of settlers. Each mission became agriculturally self-sustaining, utilizing Indian labor to operate at least 100,000 acres. In addition to cultivated fields each had its herd of cattle. The cattle quickly multiplied, and by 1800 there were probably 150,000 head in Alta California (Salitore, 1967). As an example, the Mission San Luis Obispo had nearly 20,000 livestock in the early 1800's, half of which were sheep (Engelhardt, 1963).

Settlement for non-religious or non-military purposes was very slow. Thirty years after the founding of San Diego there were only 100 colonist families in the State. Direct grants of land to individuals were at first rare. By 1821, forty years after first settlement, only 20 *ranchos* had been established (Salitore, 1967). Apparently, one reason for this slow development was that the choice land was held by the mission. Over one-sixth of the total land of California was under control of the Franciscan missionaries (Dasmann, 1965).

Independence from Spain in 1821 had little effect on life in California or its pace of development. However, secularization of the missions, starting in 1834, brought a large change in land development pattern. By 1846 about 600 private land grants had been made by the Mexican governors. These ranchos were all extensive, in no case less than 45,000 acres, and the largest over 100,000 acres. During the brief period between 1834 and the Gold Rush starting in 1848, the Rancho and cattle raising were the dominant features of life in California. In 1850 there were about one-quarter of a million head of cattle in the State. Of people, there were but 15,000 non-Indians in 1847. Los Angeles, upon incorporation in 1850, contained only 1,610 persons (Salitore, 1967). At this same time in the history of Chile the population was well over a million (CORFO, 1965).

So, as recently as the middle of the 19th century the population of California was very small and spread throughout most of the length of the State. Cattle herds reached fairly large numbers and presumably had at least local detrimental effects on the ranges during periods of severe drought which occurred with great frequentcy: 1809–10, 1820–21, 1828–30, 1840–41, and 1845–46 (Burcham, 1957).

During the Mission Period (1769–1824) many weeds were introduced

into the native California flora, including black mustard and wild oats (Robbins, 1940). By the time of Brewer's famous travels in California in the early 1860's the lower slopes of many ranges were already covered with wild oats (Farquhar, 1966). The native vegetation in such habitats was apparently already replaced by such weeds. The valleys, in many places, particularly in the south, became filled with mustard which often grew to over eight feet tall and constituted a hindrance to livestock. However, at that time the cattle were restricted to the valleys and lower slopes and did not penetrate into the chaparral vegetation. Brewer gives many vivid accounts of encounters with the chaparral where he had to crawl to make any headway.

The Gold Rush and statehood completely changed the entirely pastoral character of the State, particularly in the north. Between 1847 and 1860 the population of the State increased from 15,000 to almost 400,000 (Hansen, 1967). Tremendous demands were put upon the subsistence-type agriculture that previously existed. Demands for meat from the mining communities were great and could not at first be met by local supplies. Cattle were brought in from Texas and the mid-west. By 1862 there were 3,000,000 head of cattle on California ranges (Burcham, 1957). For a quarter of a century tens of thousands of cattle were driven from the southern ranges in the early winter up along the coast or through the Central Valley to the northern markets (Cleland, 1951).

The demand for wheat was equally great. During the early period wheat was largely imported. Chilean production supplied a portion of that needed. New land, much of it marginal for crop production, was brought under cultivation in Chile. Thus, the Gold Rush, in addition to the profound influence it had on the Californian landscape, had its effect on Chile. In California, wheat production went from 17,300 bushels in 1850 to almost 6,000,000 bushels by the end of that decade (Salitore, 1967).

The Gold Rush period marked the only significant time of contact between Chile and California. Ships from the east went by way of the Horn and made stops in Valparaiso. Alfalfa hay and seed were brought from Chile and introduced as a crop in California (Hansen, 1967). Chilean miners also made the voyage. This brief period of exchange was terminated, first by the east-west railroad connections in the United States, and finally by the opening of the Panama Canal.

The landscape destruction of California during the Gold Rush was intense. Hydraulic mining made scars which are still visible today. Forests in the vicinity of mining activity were felled. Wildlife was greatly depleted (Dasmann, 1965).

The extensive ranges of California were able to support the large cattle populations of the late 1850's during the normal and above-normal years of precipitation. However, the occurrence of a drought in 1863–64 brought disaster to the cattle industry and to the ranges. These pressures prob-

ably dealt the final blow to the native perennial bunch grasses of the Central Valley and resulted in their replacement by introduced annual gresses. As many as a third of the total cattle may have died during this natural disaster (Burcham, 1957). This catastrophe was of the same magnitude as the 1968 drought in Chile when large numbers of cattle died.

After the 1863 Californian drought the preeminence of the cattle industry was replaced by sheepraising. Sheep production, although of importance since the founding of the Missions, was always secondary to cattle raising. During the Gold Rush, sheep were brought into the State to augment the small numbers already present. By 1860, there were over a million sheep. Following the drought-produced decline of cattle raising, sheep numbers increased to almost 3,000,000 in 1870 and over 4,000,000 in 1880. Summer ranges in the Sierra Nevada were so intensely utilized by the sheep that effects are still evident many decades after their removal (Burcham, 1957). Even the arid slopes of the Desert Mountain Ranges in the eastern part of the State were visited by large numbers of sheep (St. Andre, Mooney, and Wright, 1965). Thus, during this period destruction of the ranges was spread from the valleys to the mountain slopes. Changing patterns of agriculture and fencing laws brought a large decline in the sheep industry by 1890 (Burcham, 1957).

The gold boom appreciably slowed by the 1890's. At this same time there was a reaction against the landscape destruction that was experienced during the Gold Rush period. This reaction was in part responsible for a conservation move which resulted in the formation of three national parks in the Sierra Nevada in 1890. The first of California's national forests was formed in 1892. The land controlled by the Forest Service grew to include one-fifth of the total land area of the entire State (Dasmann, 1965). The extensive parks and forests of California are carefully controlled. Their relatively early formation resulted in the protection of large areas of pristine or nearly pristine vegetation from destructive use. The parks and forests are spread throughout the State and represent most types of vegetation found within California. Large national forests include areas which cover shrub and woodland communities of the Mediterranean climatic type. In Chile, few parks or forests are included within comparable climatic and vegetation types, and these are not so tightly controlled.

In California, first Mexican land grants and later federal grants to the railroads resulted in the concentration of the land into the hands of a relatively few people during the period prior to 1880. The railroads alone held 20 million acres. Ranches existed which approached a half million acres in size (Dunne, 1967). As an example of this concentration of land ownership, almost the whole of Marin County was controlled by but 30 people (Dasmann, 1965). In southern California, in 1862, the ranch of Abel Stearns encompassed over 200,000 acres of the choicest land in the Los Angeles-San Bernardino area (Cleland, 1951).

Thus during the latter part of the 19th century the land ownership pattern was comparable to that which long characterized Chile. However, there was a great difference in the type of labor which worked these lands. In Chile, the tenant *inquilinos* were tied to the land. In return for their labor they were provided for throughout the year and essentially for life by the landowner. Their standard of living was very low. In addition to working the landowner's fields and their own small plots, often they harvested the natural products of the surrounding uncultivated landscape. There was intense and continuous activity within the center and the environs of the haciendas.

The labor to work the vast Californian farms was of a completely different nature. The major source was that of migrant workers, people who were not tied to the land, but who were brought in for the harvests. In Chile the ethnic background of owner and laborer were the same; in California this was not the case. The first large farm labor supply to the Californian farms were Chinese immigrants originally brought in for railroad construction. In the 1870's they constituted three-quarters of the farm labor force of the State. They were subsequently replaced as the prime labor supply by Japanese, and later Mexicans (Dunne, 1967). The labor supply, being of a migratory nature, probably had a limited impact on the native vegetation within or surrounding the farms.

Some of the important differences in early land use between Chile and California may be summarized as follows: although both were discovered at the same time by the Spaniards about 450 years ago, California was not settled until over 200 years later. In Chile the population grew quickly and steadily and was concentrated in the northern Central Valley. In California the population remained very low until only a hundred years ago when it started growing precipitously. The population was concentrated in several areas at places distant within the State.

There probably has been continuous misuse of the natural landscape in Chile throughout its entire history through grazing practices, burning and wood gathering. Destructive land use in California was especially concentrated in the latter half of the 19th century when it reached monumental proportions principally through overstocking in ranges. The formation of large forest reserves and parks at the turn of the century resulted in the preservation of large segments of the natural landscape. There has been no comparable conservation move in Chile.

Large agricultural landholdings have been characteristic of both Chile and California; however, the nature of the labor supply has been very different in both and has resulted in dissimilar land treatment.

The Present

At present the population of Chile is about half that of California, although its areal extent is nearly twice as large. In 1960 there were 7,727,662 people in Chile (CORFO, 1965) and in California, 15,717,204 (State

of California, 1967). Chile has an area of 286,369 square miles as contrasted to the 158,693 square-mile area of California. Three-quarters of the Chilean population is concentrated in the central zone between La Serena and Concepcion (James, 1959), with one-third centered in the 6,700 square-mile province of Santiago alone. California, on the other hand, has two geographically separated population centers, the southern California coastal region between Los Angeles and San Diego, and the San Francisco Bay area, the former being the denser of the two. In 1960 there were over 6 million people in the 4,000 square miles of Los Angeles County (State of California, 1967).

Although the rural populations of both Chile and California have declined markedly in recent years both are still important agricultural regions. In California only 4.6% of the total labor force is engaged in agriculture, yet it leads the nation in crop value and is second in livestock production (Salitore, 1967). Chile is still much more rural in character with 27% of the Chilean labor force engaged in agriculture at present (CIDA, 1964). The percentage of cropland in both California (Parsons and McCorkle, 1963) and Chile (CIDA, 1966) is approximately 10%. Almost 6½ million acres of California croplands are irrigated as are approximately 3½ million acres of Chilean land.

Range and pasture land accounts for over a third of the total area of Chile (CIDA, 1966) and a quarter of California (Parsons and McCorkle, 1963). The pattern of stock raising in the two areas is quite different. California has nearly 5 million cattle, one and a half million sheep and about 200,000 hogs and pigs (State of California, 1967). Goats are very low in number. The great majority of the cattle are raised on feed lots. Grazing on public lands is now strictly controlled (Salitore, 1967). Chile, on the other hand, has about 3 million cattle, over 6 million sheep, which are concentrated mostly in the south, and nearly a million hogs and pigs. The most significant difference relating to landscape treatment between California and Chile, however, is the fact that Chile has a population of over a mililon goats (CORFO, 1965). The majority of these goats are concentrated in the province of Coquimbo to the north of Santiago (Matthei, 1939). Covarrubias *et al.* (1934) have vividly described contemporary mismanagement of land in this depauperate region by overgrazing, principally by goats, cutting of trees and shrubs for firewood and charcoal and the marginal dry land cultivation of wheat. This area includes the transition between the matorral and desert vegetation types.

The amount of forested land in Chile is rather small, less than 15%, 1½% of which is in plantations (CIDA, 1966). In contrast, nearly 43% of the California landscape is forested (Salitore, 1967). Many aspects of the management of these lands differ greatly between California and Chile. One of the more important differences is that of fire control. An extensive and elaborate network of fire-control stations exists throughout the forest and woodland regions of California, as well as in urban areas.

In contrast, in Chile fire-fighting activities are more or less limited to the vicinity of urban centers (FAO, 1967).

Vast areas of California are owned by the government. Of the total area of the State of 100,207,000 acres, 44% is controlled by federal agencies. The Department of Agriculture alone manages 20% in National Forests and the Department of Interior somewhat more in National Parks and in the holdings of the Bureau of Land Management. These lands include considerable tracts of woodlands and scrublands in addition to forests (State of California, 1967). In Chile, only about 6% of the land is in forest reserves and 3% in national parks; virtually none of these lands are holdings which include Mediterranean-climate scrub vegetation (CIDA, 1966).

Summarizing the important differences in contemporary land use between Chile and California which relate to the comparative conditions of the natural vegetation of the Mediterranean-climate ones: California has a great amount of land, including much scrubland, which is closely administered by various governmental agencies; grazing activities on natural pastures are now minimal and fire protection great. The population of California is primarily urban and concentrated in two geographic centers. In contrast, very little of Chile's land is under governmental stewardship. Poor grazing practices still exist. There is little fire control. A large portion of the population is still engaged in agriculture. The most intensive use of the landscape is centered in the Santiago region.

Future changes in the natural vegetations of these regions will occur at increasingly greater rates as the populations grow. The populations of both California (Salitore, 1967) and Chile (CIDA, 1964) are increasing at an annual rate of about 2.5%. Massive urbanization in California is pushing agriculture out of the productive valleys and on to the slopes and into the deserts. Atmospheric pollution is affecting not only the crops near the urban areas but the natural vegetation at increasingly higher elevations in the mountains. Bulldozers are reshaping the entire landscape with new dams, new roads and sites for new homes. The assault on the Chilean landscape will be as great but the weapons of destruction will be not as forceful because of the lower degree of industrialization and mechanization of the Chilean society.

Conclusion

The northern sclerophyll region of Chile which centers in the Santiago area has had a very long history of intensive mistreatment which includes overgrazing, woodgathering, and frequent burning. This could explain why the extant vegetation in this region has a more xerophytic character than does the homologous chaparral vegetation type which occurs in California under essentially identical climatic conditions.

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AN ANNOTATED CHECK LIST OF THE GROVES OF SEQUOIADENDRON GIGANTEUM IN THE SIERRA NEVADA, CALIFORNIA

Philip W. Rundel

Department of Population and Environmental Biology,
University of California, Irvine 92664

One of the outstanding characteristics of *Sequoiadendron giganteum* (Lind.) Buchh. (Taxodiaceae) is its disjunct distribution, restricted to a series of relatively distinct groves extending along the west slope of the Sierra Nevada of California. *Sequoiadendron,* whether known as giant sequoia, big tree, or Sierra redwood, is clearly one of the most prominent species of plants in the world and this fact has led to the present preservation of more than 95% of the area of existing groves in publicly